E7.3 10661.
CR-132170

(E73-10661) GEOGRAPHIC ANALYSIS OF LANDSCAPE CHANGE FROM ERTS-1 IMAGERY Progress Report (Tennessee Univ.) 26 p
HC $3.50 CSCL 08F
N73-25357
Unclas
G3/13 00661

# GEOGRAPHIC ANALYSIS OF LANDSCAPE CHANGE FROM ERTS-I IMAGERY

TYPE II REPORT

DR. JOHN B. REHDER, P.I.
UN 212

NASA-ERTS GEOGRAPHY
Remote Sensing Project
Contract NAS5-21726

Department of Geography
University of Tennessee
Knoxville, Tennessee



June 1973

# Geographic Analysis of Landscape Change From ERTS-I Imagery

Dr. John B. Rehder
NASA-ERTS Geography Remote Sensing Project
Department of Geography
University of Tennessee
Knoxville, Tennessee

Type II Progress Report

June 1973

## INTRODUCTION

Since our last reporting period, the NASA-ERTS Geography Remote Sensing Project has been involved in two areas of concern: (1) A major reporting activity period in which five papers were presented and five publications have been either put in press or are now released and (2) research activity based on the continued analysis of ERTS imagery, the additional generation of ground truth imagery, and field work for ground truth analysis and evaluation.

Two problems have entered the project and are now being persued for their solution. The first involves the loss of data between Jan.12 and present (June) for the central and eastern portions of our test area. By some unknown action, the standing order coordinants for two of the four orbits in our study area were removed from the user services computer at Goddard Space Flight Center. In reconstructing the basis of the problem, we have come to the conclusion that when we submitted a modification to the original standing order to add two orbits west of our study area, the computer added the two western orbits but removed the two eastern ones. (Figure 1) We hope that the problem can soon be rectified. Back orders have been placed to replace the missing imagery and at present we are awaiting shipment of these from Goddard.

The second problem concerns the question of insufficient time for the completion of the project at government exposure beyond the project deadline. Heretofore, our proposal was based upon the expectation that ERTS-I would operate for one year from the date of launch, consequently, our original timetable was based upon a 15 month study period. Because of delays in launch and subsequent delays in the reception of ERTS imagery and data, we are placed at the initial analysis sequences of phase III

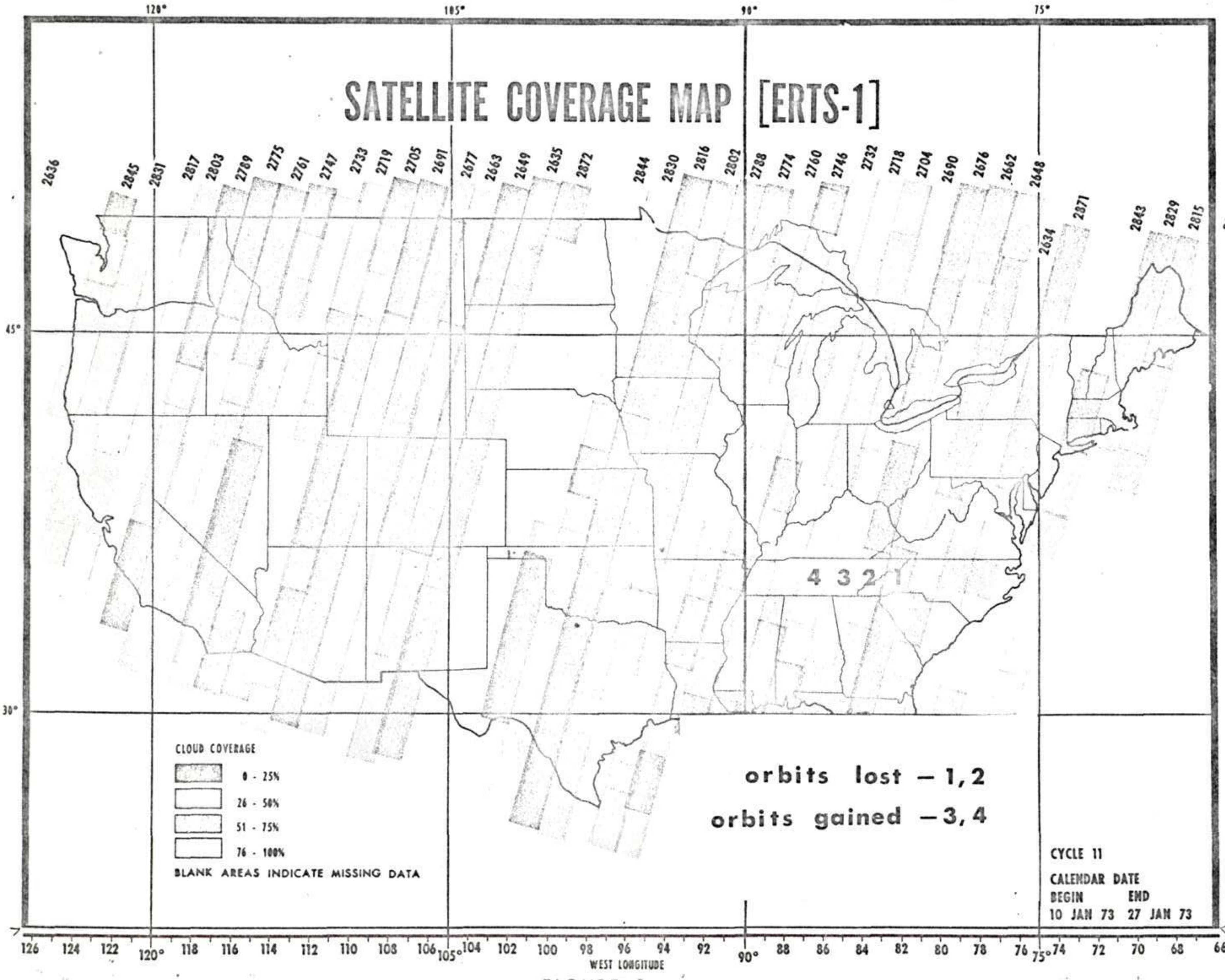

SATELLITE COVERAGE MAP [ERTS-1]
CLOUD COVERAGE
0 - 25%
26 - 50%
51 - 75%
76 - 100%
BLANK AREAS INDICATE MISSING DATA
orbits lost — 1, 2
orbits gained — 3, 4
4 3 2 1
CYCLE 11
CALENDAR DATE
BEGIN END
10 JAN 73 27 JAN 73
WEST LONGITUDE
NORTH LATITUDE

FIGURE 1

of the established data analysis plan. According to our present needs for continuation, we forsee the necessity of the analysis period extended to August 1974.

Part of this second problem is inherent with any study concerned with landscape change detection. Man's actions on the landscape are small on a cell for cell basis and an investigation such as this one requires an extended period of time to detect and monitor changes over time. The aggregate of man's landscape modifications simply requires more than a 12 to 15 month period of observation. Temporarily, we have been analyzing ERTS data for Oct. 15, 1972, January 1973, and April 14, 1973. Each date represents a different season and a different but singular temporal slice of time. Change detection and analysis is indeed but minimally available from this arrangement of time but cyclic patterns and season to season changes are limited at present to only a single annual set of observations. Based on our present data set and what we can expect until December 1973, the present contract deadline of the project, this only gives us one annual cycle of coverage. Thus the ERTS data for Oct. 1972 and Oct. 1973 is the only opportunity for the analysis of an annual sequence of the coverage.

In view of the dynamics of landscape change which are seasonally restrictive: (ie. agriculture cycles and phenological changes in natural vegetation) we forsee the need for ERTS imagery and its analysis for the project to extend into the summer of 1974.

## Reporting Activities

As with any good business or research practice, the dissemination of information about significant results and activities is one of paramount concern. Good public relations and the reporting of significant information at professional meetings and in professional publications benefit all interested parties. Thus, the primary activity of this principal investigator between January and May was the reporting of significant research results from the NASA-ERTS Geography Remote Sensing Project. Table 1 summarizes the list of papers and the intensive reporting schedule involved. With the presentation of 5 papers the news of our activities reached a considerable audience of approximate 800 or more persons. Among those in attendence were various government officials at the Goddard meetings, space scientists at Tullahoma, Tennessee, former AEC director David Lilienthal and present TVA chairman of the board J. Wagner in Chattanooga, a nationwide cross section of geographers in Atlanta, and a host of American scientists and officials from all over the Americas and principally from Latin America at the Panama meetings. Such good publicity can only be good for the ERTS program and NASA and we are proud to have had a part in the dissemination of our significant results over such a broad spectrum.

## Research Activities

Research Activities during this reporting period have included low altitude aircraft missions, ground truth investigations, and continued imagery enhancement and analysis of ERTS-I data.

Low Altitude aircraft missions were flown on April 13, 1973 over the Cumberland Plateau Test Site for purposes of obtaining ground truth imagery of strip mine activities. (Figure 2) The flight was conducted by the principal investigator and James R. O'Malley-graduate research assistant in the University of Tennessee Research Aero Commander aircraft

Table 1
Reporting Activities
Papers and Publications
Jan 1-May 1

| Title | Sponsors & Place | Date | Copy at N.T.I.S. | Published/to be published |
|---|---|---|---|---|
| Geographic Applications of ERTS-I Imagery to Landscape Change (162-III): Summary | <u>IEEE. Transactions On Geoscience Electronics</u> Vol. GE-11 #1, January 1973 p. 26 | January 1973 | Yes | Yes/ |
| Enhanced Imagery from ERTS-1 of the Eastern Tenne-ssee-Southern Appalachian Region | Ambionics Inc. Attn. William Bailey, Southern Building, Washington, D.C. 20005 | January 30, 1973 | Yes | /Yes |
| Geographic Applications of ERTS-I Data to Landscape Change | NASA-Goddard Symposium on significant results obtained from ERTS-I<br>Sheraton Motor Inn, New Carrollton, Md. | March 5-9 1973 | Yes | /Yes |
| Geographic Applications of ERTS-I Imagery to Rural Landscape Change in Eastern Tennessee | "Second Annual Remote Sensing of Earth Re-sources Conference"<br>University of Tennessee Space Institute Tullahoma, Tennessee | March 26-28 1973 | Yes | /Yes |
| Geographic Applications of ERTS-I Data to Landscape Change | Association of American Geographers Annual meet-meetings. Special Interest Group "The Uses of ERTS Imagery in Geography" Atlanta, Ga. | April 15-18 1973 | Yes | No/No |
| The Earth Resources Technology Satellite (ERTS) | Chattanooga Engineer's Club. (with David Lilienthal-former A.E.C. Chairman and A.J. Wagner-present Chairman of TVA in attendance) Chattanooga, Tennessee. | April 23 1973 | Yes | No/No |

| Title | Sponsors & Place | Date | Copy at N.T.I.S. | Published/to be published |
|---|---|---|---|---|
| Geographic Applications of the Earth Resources Technology Satellite (ERTS-I) to Landscape Change | 1st Pan American Symposium on Remote Sensing<br><br>Sponsored by:<br>Pan American Institute of Geography and History/USGS-EROS/ Inter American Geodetic Survey/Organization of American States/Instituto Geografico Nacional/- Panama, Republic of Panama | April 28, 1973 | Yes | /Yes |

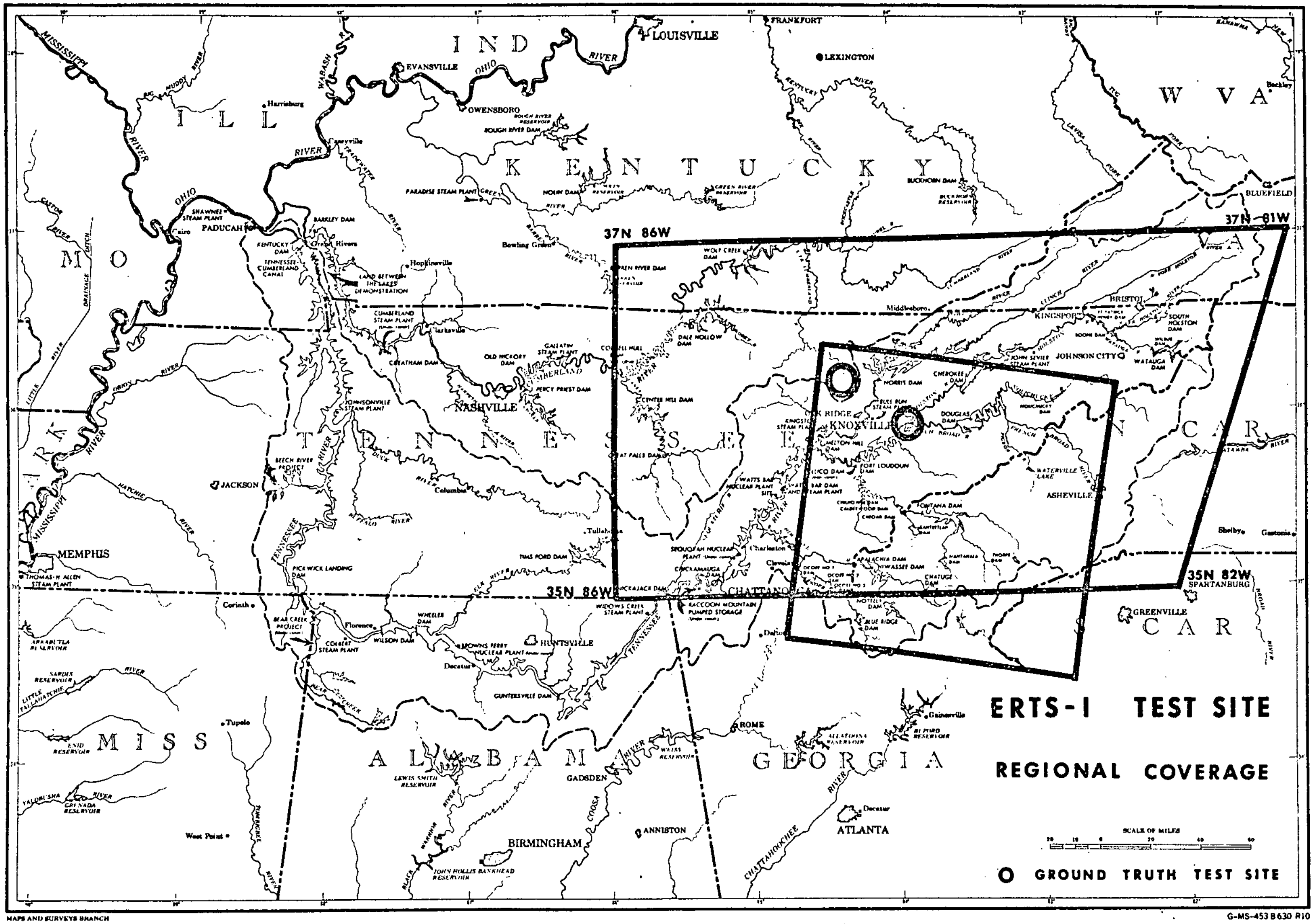



FIGURE 2. Map of the East Tennessee Test Site. The upper circle identifies the Cumberland Plateau Test Site.

at an altitude of 7000'. Although cloud cover hampered a complete coverage mission, the data obtained from the flight were invaluable in confirming that strip mining was actively continuing at several mining sites. Several months previously we had detected landscape change in the area by comparing RB-57 high altitude aircraft data from April 1972 with ERTS data in October[1]. However, this April 1973 mission not only confirmed the existence of continued mining but it was also temporarily useful for comparison with the April 1972 aircraft imagery.

The four images in Figure 3 are 70 mm contact negative prints of selected strip mine operations. Image 1 illustrates the nature of a newly cleared (deforested) swath of ground which has been prepared in anticipation of continued strip mining of coal. This clearing represents the initial landscape change activity in strip mining. Because of the high reflectance of the sandstone surface, the cleared area appears "brighter" than the surrounding forested background. (Note all illustrations shown here are negative prints, thus dark tones are in reality light, bright tones on the original color infrared and ektachrome imagery). Additionally the swath in image 1 also appears on the ERTS image for April 14, 1973 (see Figure 8).

Image 2 of the 70 mm negative prints illustrates the surface contrasts between a swath of newly cleared land (at C) and a swath of land actually being stripped for coal at the cutting edge of the strip mine operation (M). Image 3 further illustrates the same active mine as in image 2. Here one can detect a rough gouged surface, road tracks,

---

[1]Rehder, Dr. John B. "Geographic Applications of ERTS-I Data to Landscape Change" presented at the NASA-Goddard Symposium on Significant Results Obtained from ERTS-I. Sheraton Motor Inn, New Carrollton, Md. March 5-9, 1973.

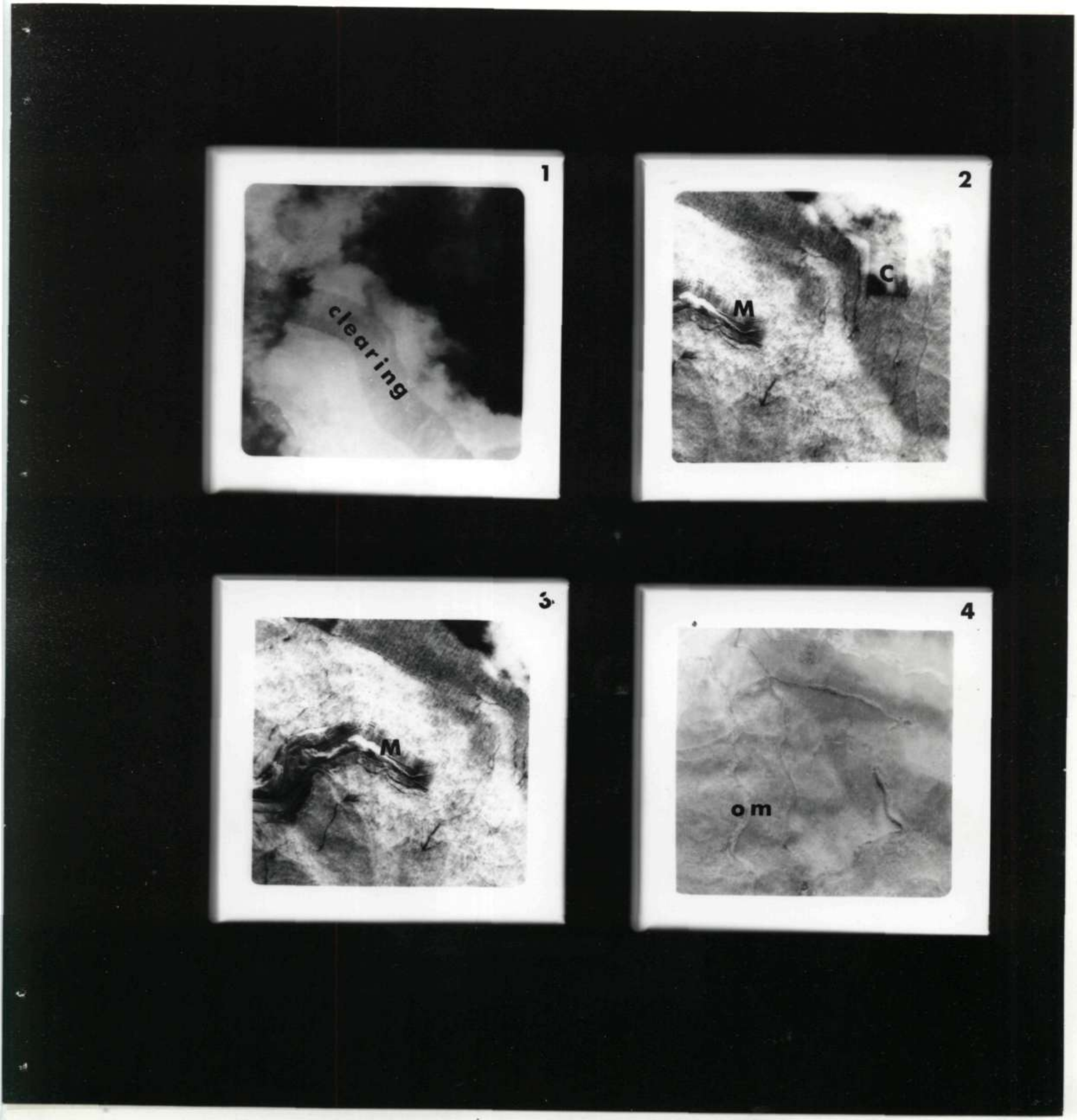



FIGURE 3. Low Altitude Negative Prints of Strip Mine Signatures on the Cumberland Plateau, Tennessee.

deep pits where an auger is being used, and in general the roughened signature of an active strip mine. Image 4 illustrates the relative healing of old strip mine scars (OM). Although they are quite visable from this altitude of 7000', they do not clearly appear on the ERTS imagery. A haracteristic signature of old strip mines, however, is their narrow width of 30' to 75' as compared with 300-' 500' for the newer active mines which are wider because of more modern, wider, mining equipment. Another signature is the natural vegetation which is reclaiming the scars with pines, scrub oak, brush vegetation and around water filled depressions cat tails and other water tolerant grasses. The smaller size of the older mines and the revegetated surfaces account for their apparent obscurity on the ERTS imagery.

Additional ground truth investigations were conducted on the Cumberland Plateau strip mines on May 12, 1973. Particular emphasis was given to one of the more active mines in the area as located by the arrows on figures 4 and 8. Ground observations were made and photographed to illustrate the internal characteristics of the surface mines. Figure 5 illustrates the nature of cuts, road bed, and fill materials. Revegetation and reclamation work is being conducted by the mining company in the form of reseeding and fertilizing spoil banks and replanting with pines. (appendix). Although the aircraft ground truth work done in April 13, 1973 provided evidence of continued mining activity, the "true" ground truth of May 12, 1973 provided addition positive evidence of details within the surface mines as well as information about the reclamation of abandoned mines.

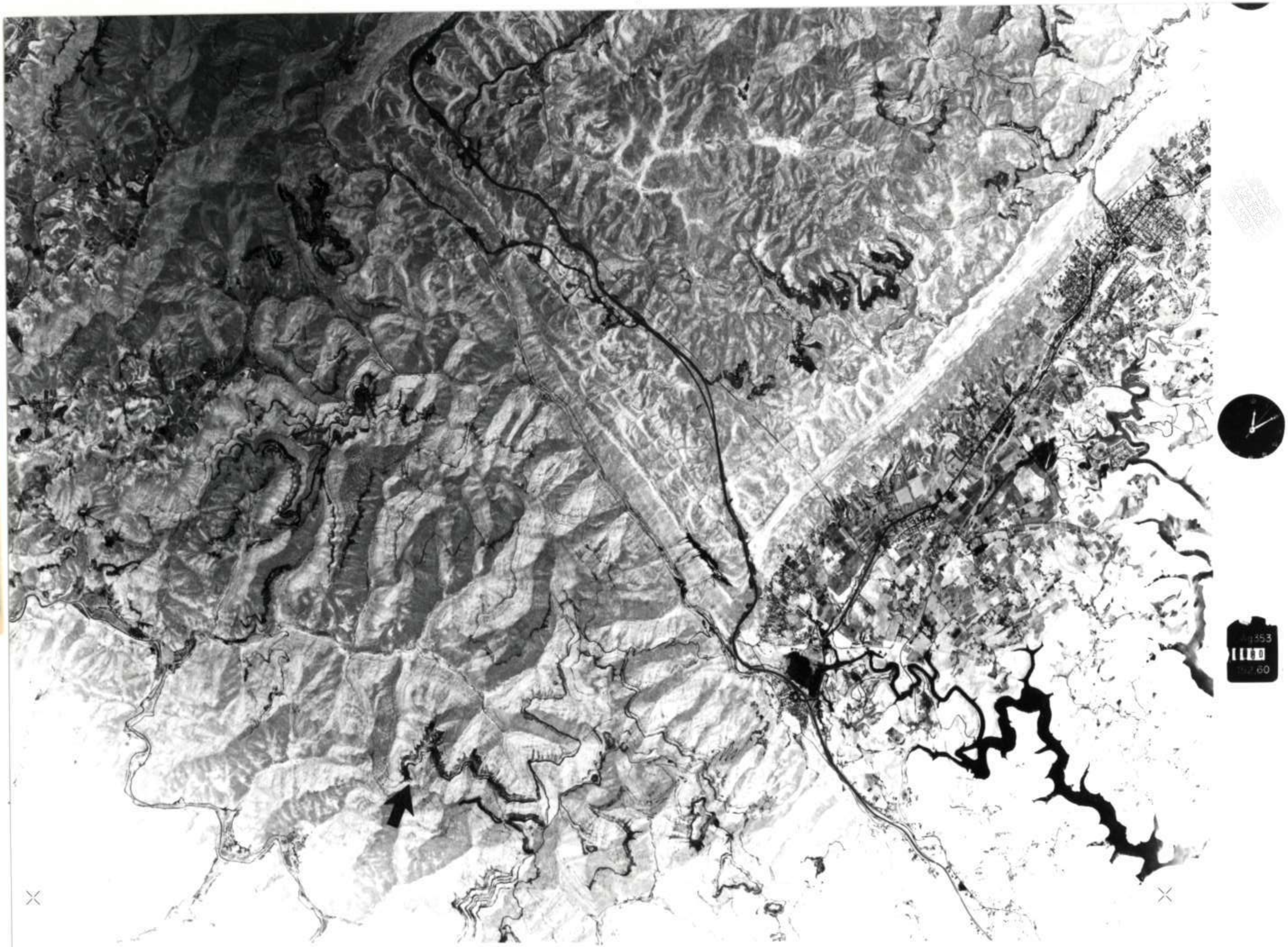


FIGURE 4. RB-57 High Altitude Aircraft Image of Strip Mines on the Cumberland Plateau. Arrow indicates the mine shown in figure 5.

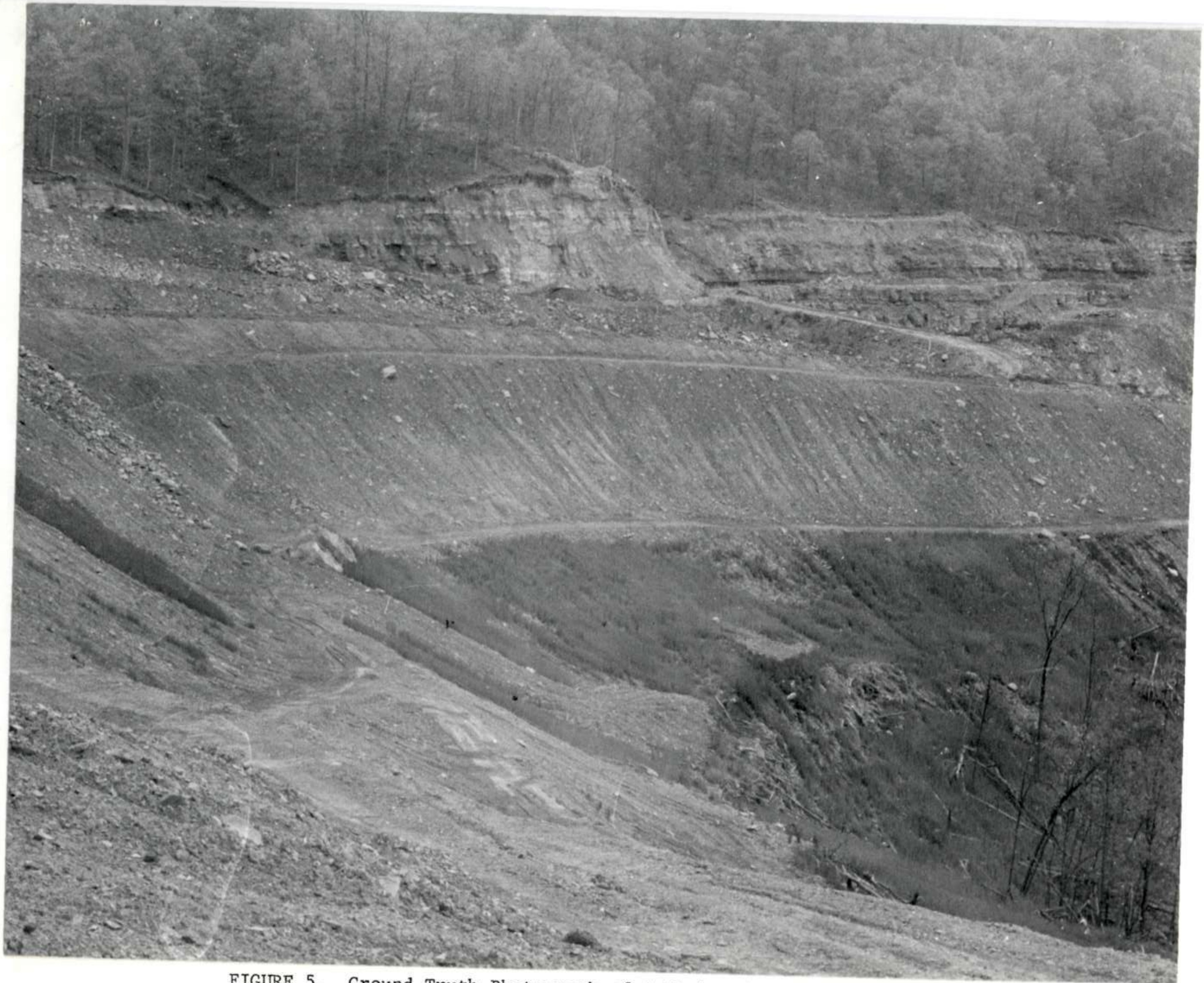


FIGURE 5. Ground Truth Photograph of A Strip Mine on the Cumberland Plateau.



B

With regard to the mapping of landscape change parameters, we have initiated several mapping projects either in the planning stages or underway. One map product just completed by a student advisee depicts the changing landscape with respect to strip mines on the Cumberland Plateau. As a part of his thesis, Captain James Johnson, U.S. Army and graduate student under my direction, is mapping the surface changes on the plateau between the dates of April 18, 1972 and October 15, 1972.

Figure 6 illustrates the before and after nature of the landscape changes created by strip mining. The black shading indicates the extent surface mines as of April 1972 and the gray shading illustrates the "new" strip mines as of October 1972. Although the mapped data were derived from RB-57 aircraft and ERTS imagery and then reproduced at a scale of 1:120,000 comparable to that of the RB-57 aircraft imagery scale, the results are clear. Landscape changes are indeed rapidly taking place in a considerable area and these changes are detectable from ERTS imagery. We feel that this represents a significant result from the analysis of data from ERTS.

Another map product is a forest map of Tennessee prepared by Earl J. Tullos - graduate research assistant under my direction (Figure 7). Using ERTS-I imagery alone, Tullos has produced a map of forest cover for the state of Tennessee. Total time required in reducing the five ERTS images to map scale and transfering the data to an original map was three hours. With ERTS, time efficiently like this indeed provide a cost benefit of many thousands of dollars and many man-days as compared with conventional methods. Had he used high altitude RB-57 imagery at 1:120,000 scale as his data base, he would have required 146 images,

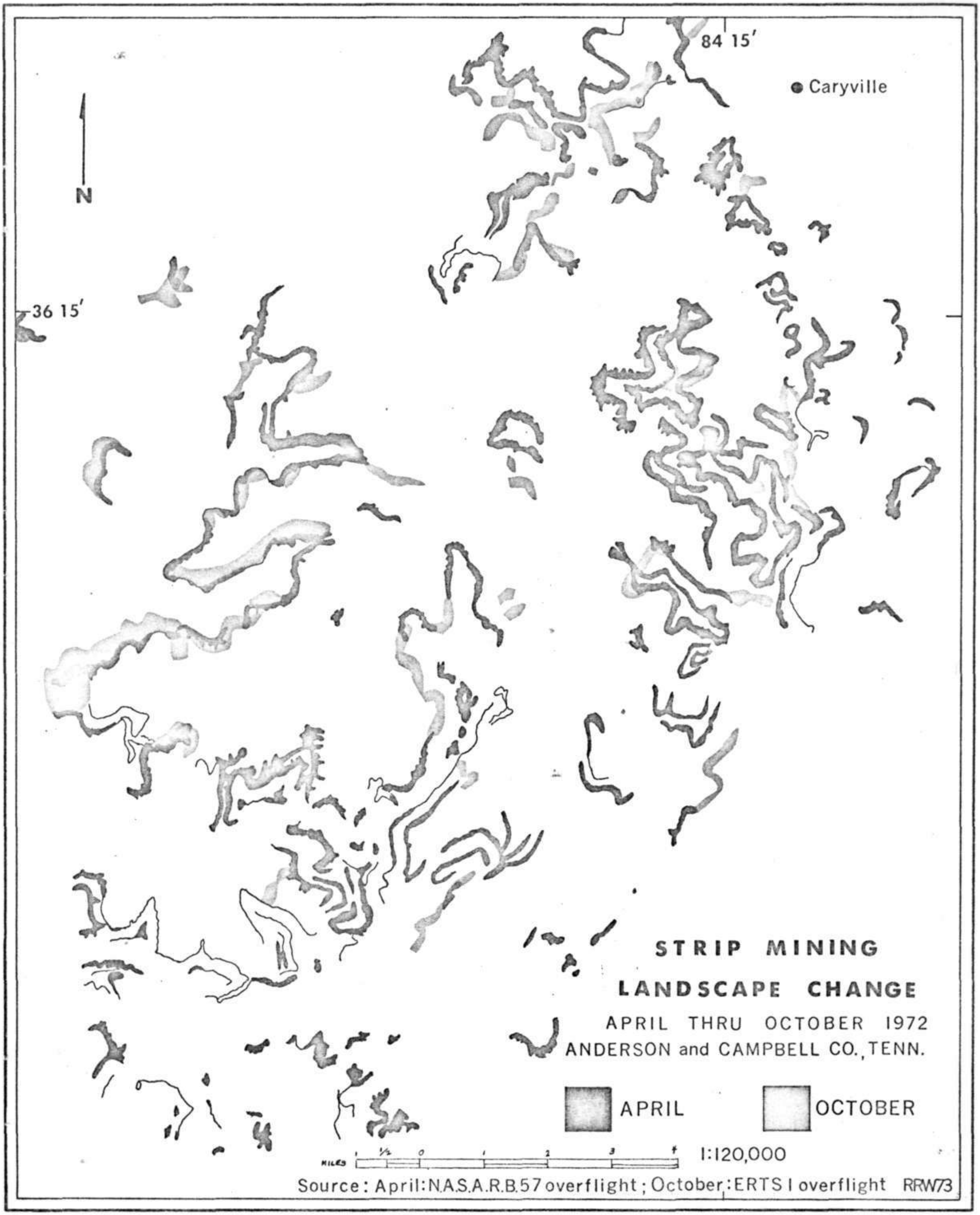



FIGURE 6. Landscape change created by strip mining on the Cumberland Plateau Test Site. April - October, 1972.

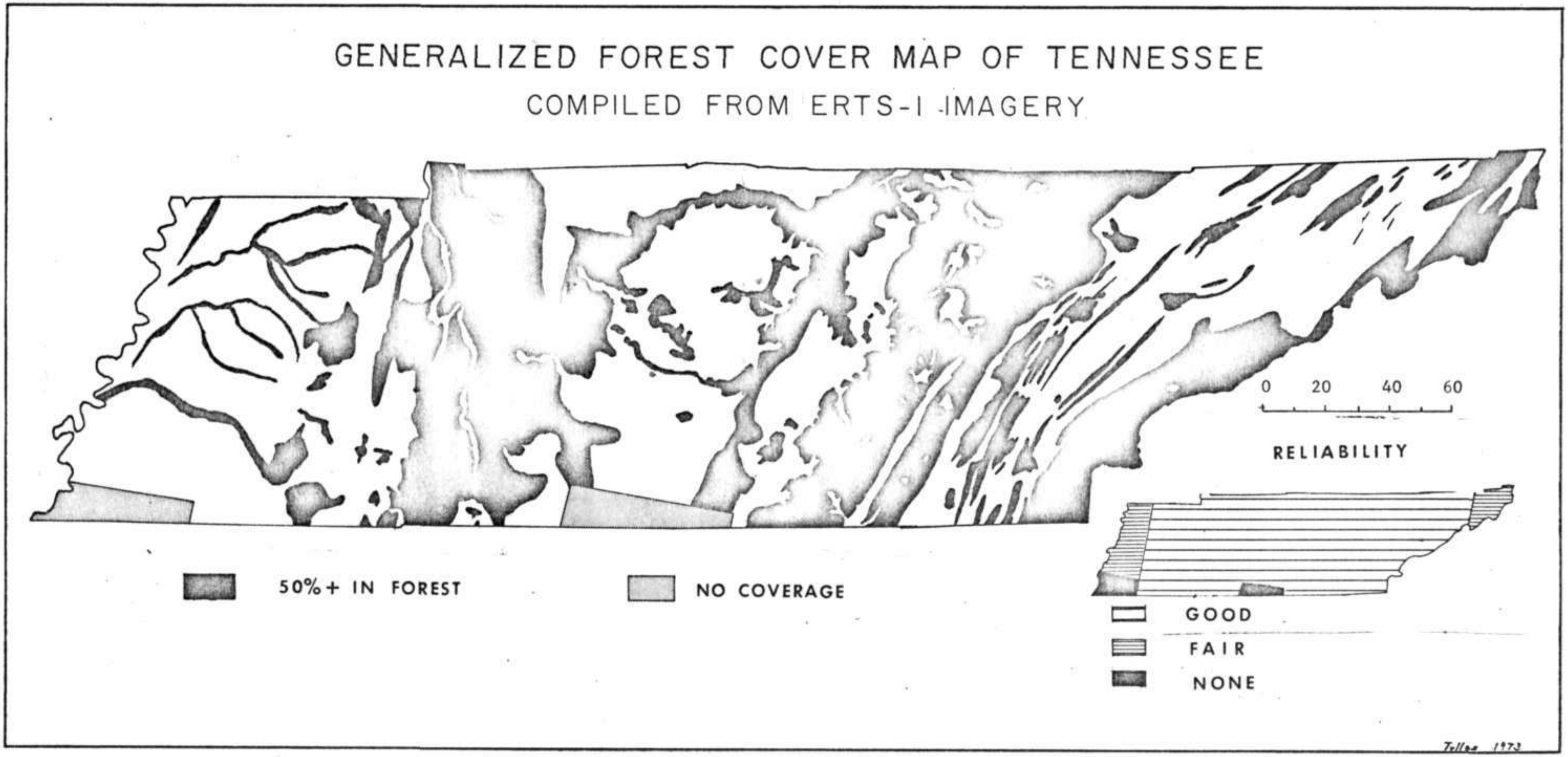



FIGURE 7. Forest Cover in Tennessee.

approximately 60 man days, and over $150,000 worth of imagery.

One of the more significant results established during this reporting period concerns the detection, identification and mapping of plowed fields within the western portion of the study area. Heretofore our imagery analysis efforts have focused upon the more dynamic strip mining landscapes and the suburban growth areas west of Knoxville. The agricultural scene was initially obscure on the August imagery, almost microscopic on the October imagery, and snow covered and dormant on the January data. But for April the agricultural scene emerged as a significantly dynamic landscape surface of plowing patterns and cleared fields.

The agricultural landscape of East and Middle Tennessee is dominated by a caotic pattern of tiny fields, some measuring one-third acre or less. Even the largest of fields measure no more than 50 acres. Thus we were pleasantly surprised to find that the most reflective features on the imagery were recently plowed fields.

Figure 8, a negative contact print produced from a Band 5 positive transparency for April 14, 1973 illustrates the pattern of plowed fields shown as black dots in the central and southern portions of the image. In general, every dot and line of deepest darkest intensity reflects the existence of a bare soil surface. Dots and blocks are cleared plowed fields while the dark linear feature in the southeastern portion of the photo is the cleared road bed and right of way of highway construction on Interstate 75.

In Figure 9 we can detect and map plowed fields in the area immediately south of the preceeding image in Figure 8. In this southerly locale, Sand Mountain, Alabama (SM) reflects plowing activity to the greatest and most extensive degree as shown in the lower left center of the image.

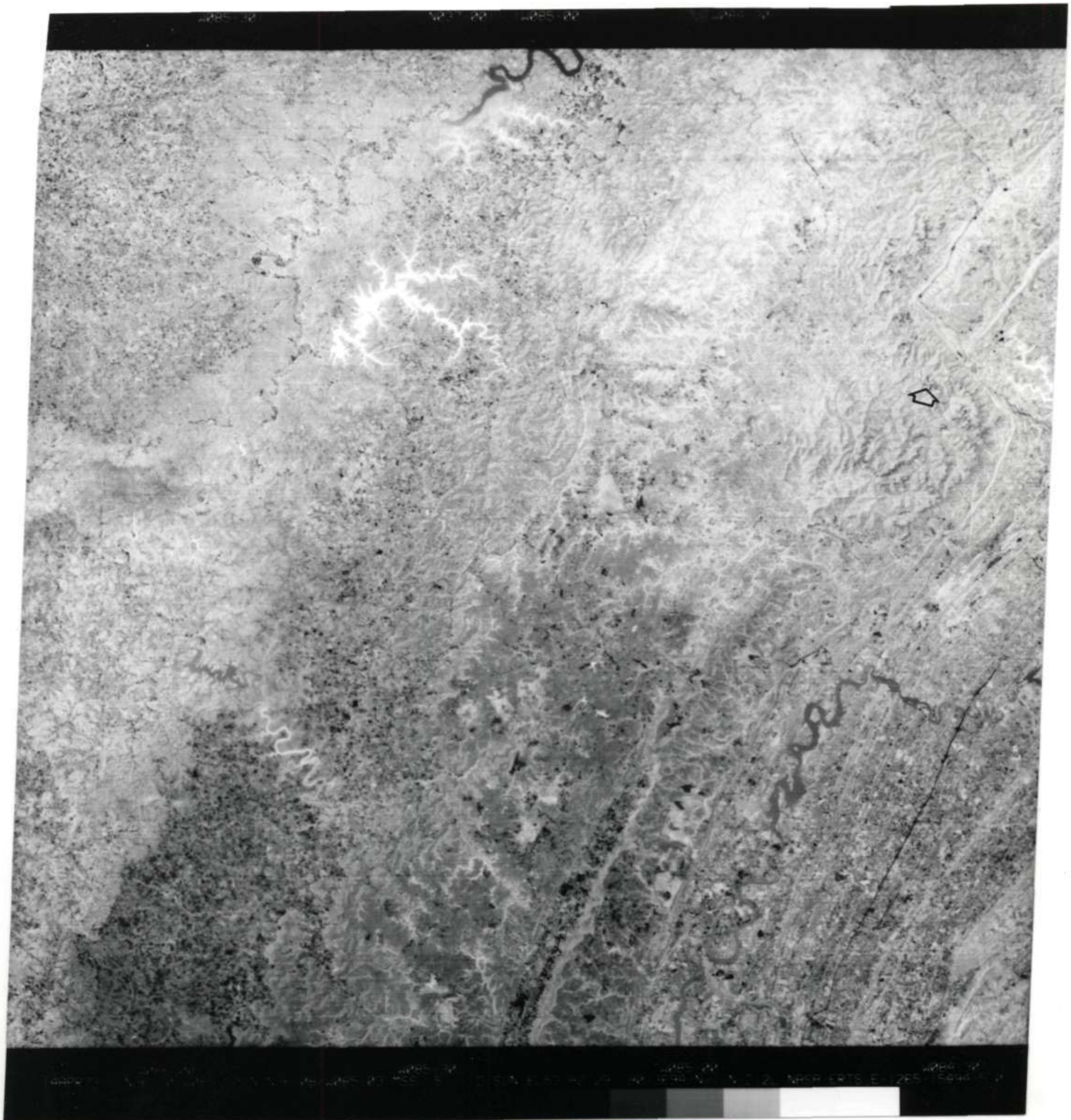




FIGURE 8. ERTS band 5 negative print showing plowed and cleared earth features in Middle and Eastern Tennessee. April 14, 1973.

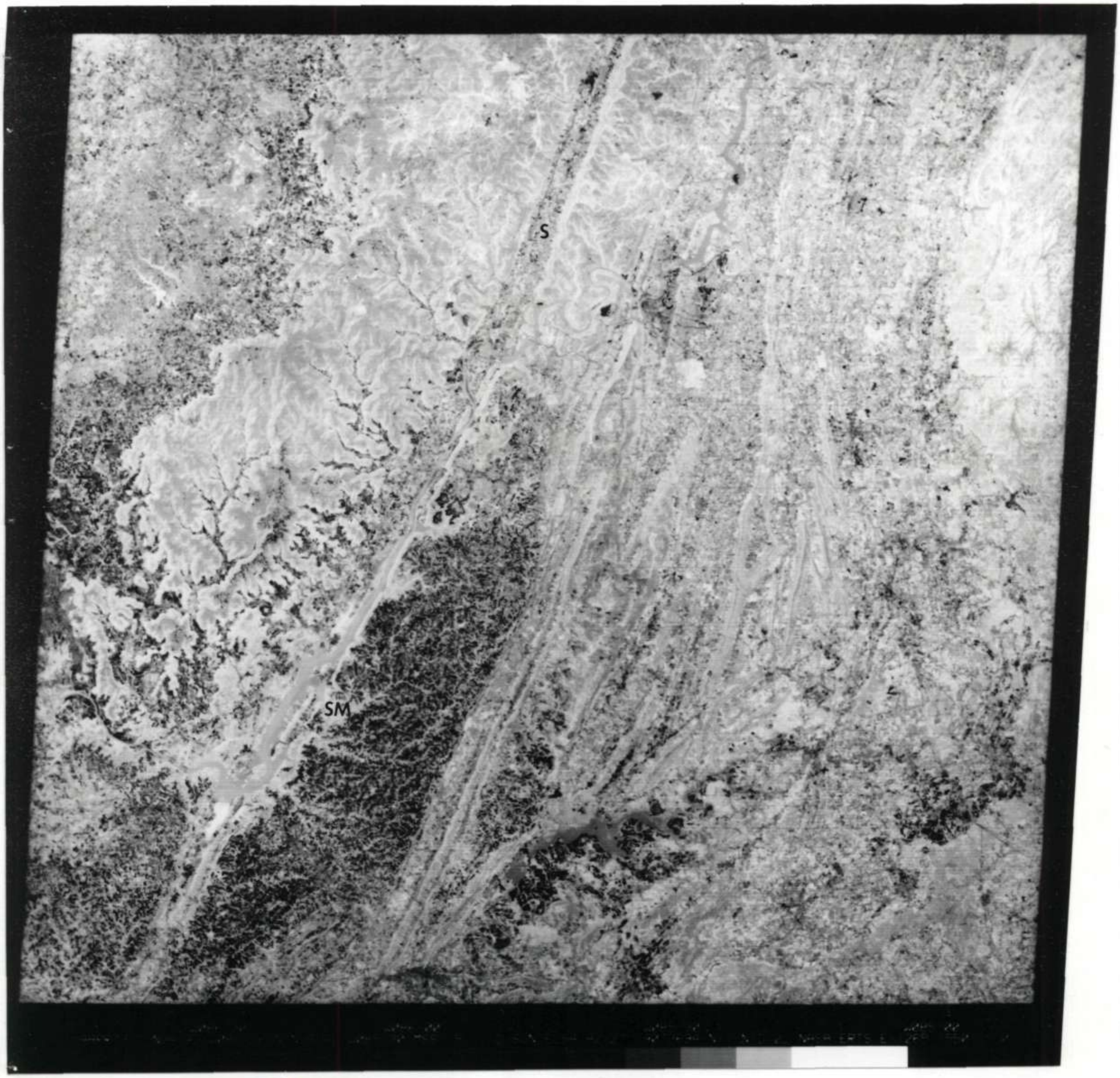





FIGURE 9. ERTS band 5 negative print showing plowed fields in the Sand Mountain, Alabama area. April 14, 1973.

Note the finger-like extensions of agricultural lands reaching into the valley bottoms of the dissected plateau areas west of Sand Mountain. West and Northwest of the Cumberland Plateau, the area in light gray tones, we again see the plowed fields of the Highland Rim and Plateau of the Barrens, landscapes of moderate relief and agriculture. Viewing East and North in the upper center of the image at (S) we can detect minor plowing patterns in Sequatchie Valley. Southeast of this area, the city of Chattanooga, Tennessee (C) is illustrated by dark gray tones and dark lineations of east-west roads on the image. Finally in the southern and eastern portions of the image, significant agricultural areas are evidenced by the concentrated patterns of plowed fields are identifical in the Gadsden, Alabama-Rome, Georgia area.

## Conclusions

Within the past four to six months the NASA-ERTS Geography Remote Sensing Project under the direction of Dr. John B. Rehder, Principle Investigator, has been involved in the dissemination of information through significant reporting activities and at the same time has continued research activities in imagery enhancement and analysis. As of this writing, we are continually discovering more and often better information from the ERTS data system, and we foresee significant uses of subsequent data from ERTS in the future.

APPENDIX

Long Pit Mining Company
Massengale Mountain
Caryville, Tennessee
Campbell County

Experimental Mining Area

| Coal Seams Being Mined | Average Thickness | Elevation |
|---|---|---|
| Red Ash | 38" | 2460 |
| PeeWee | 48" | 2510 |
| Walnut Mountain | 48" | 2515 |
| PeeWee Rider | 30" | 2560 |

Experimental mining began July 2, 1972

Estimated completion date--July 1974

Source: Mr. Fred Wyatt
Tennessee Department of Conservation
Division of Strip Mine and Reclamation

Long Pit Mining
Experimental Area
Mining Method

1. Take one cut on Red Ash Seam creating a 20' vertical outslope. Remaining material to be hauled off to pit created from last cut on the conventional mining area.

2. Two cuts will be taken on the PeeWee and Walnut Mountain Seams. Material from the first cut will be placed in the pit created by the cut on the above mentioned Red Ash Seam. Material from the second cut will be hauled to the pit of the conventional mining area or off-site storage area.

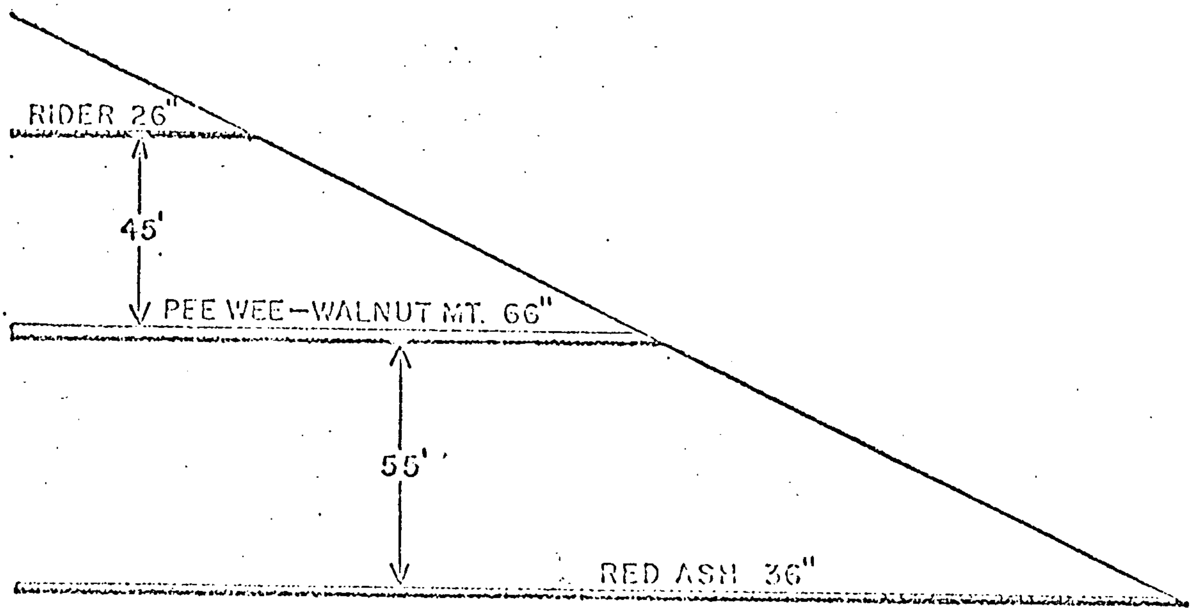
3. One cut will be taken on the PeeWee Rider Seam. Spoil material will be placed in the pit created by the PeWee and Walnut Mountain Seams.

4. Roads are to be constructed on the outer 20' of solid outslope.

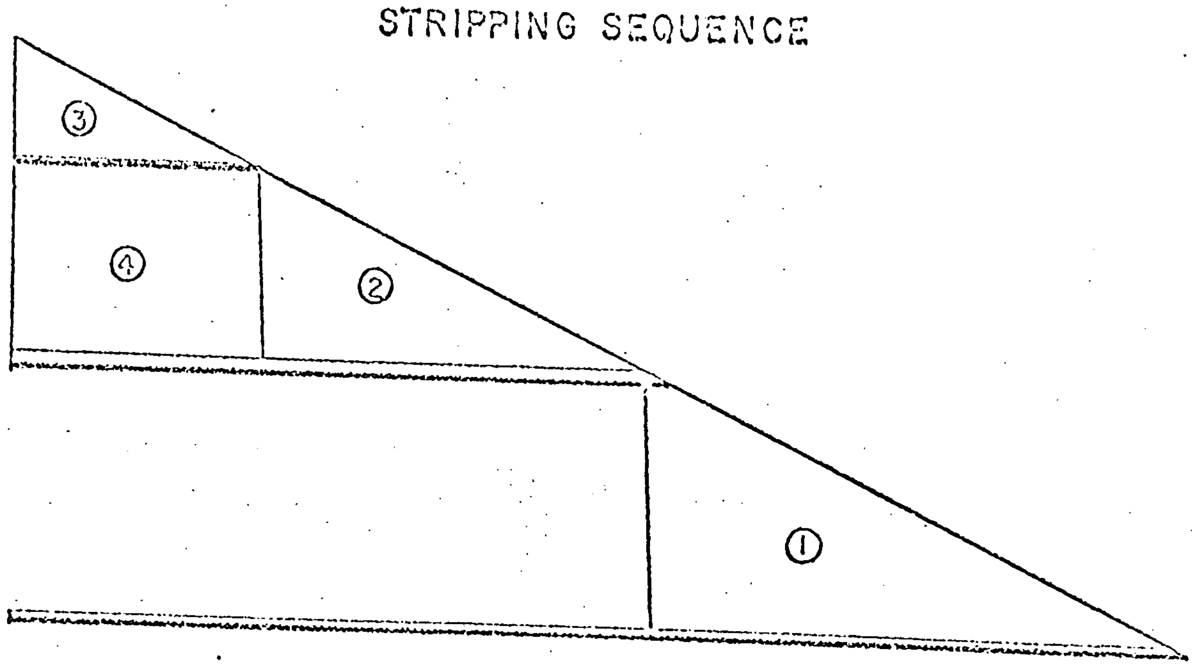
NOTE: Augering will take place on all seams.

22

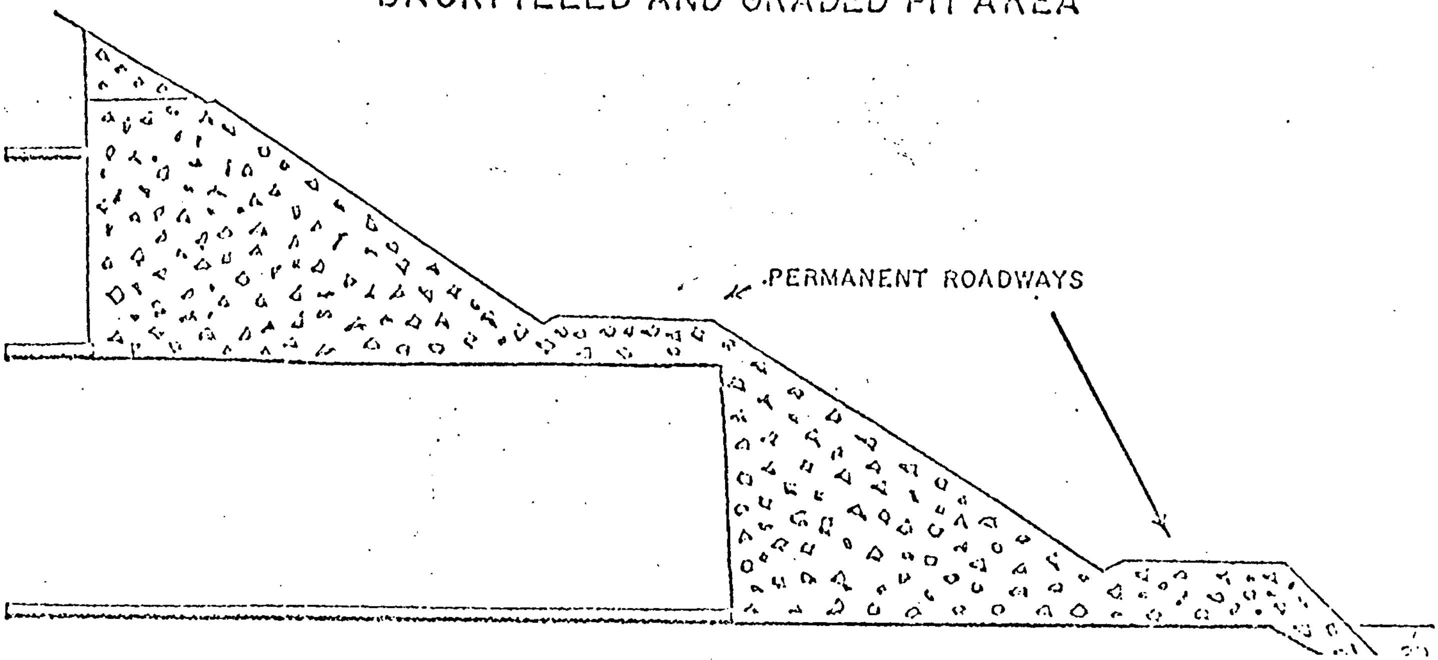
MINING AREA WITH SEAM INTERVALS




STRIPPING SEQUENCE



APPROXIMATE FINAL PROFILE OF
BACKFILLED AND GRADED PIT AREA




Revegetation Plan
Long Pit Mining Company

| Item | Amount per Acre |
|---|---|
| Ky 31 Fescue | 20 lbs. |
| Annual Ryegrass | 10 lbs. |
| Korean Lespedza | 10 lbs. |
| Bicolor Lespedza | 250 seedlings |
| Pines | 750 seedlings |
| Ammonium nitrate | 150 lbs. |
| Super triple phosphate (0-46-0) | 250 lbs. |
| Wood fiber mulch | 1500 lbs. |